Valuing Endangered Species: Wolves and Turtles

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Outline of Presentation

(A) Concepts / Methods / Policy Issues
(B) Applications– Contingent Valuation
-- gray wolf / Yellowstone NP
-- grey whale / W. Coast US
-- sea turtle / E. Coast US
-- overview / meta analysis
(C) Validation of Contingent Valuation
-- arctic grayling / Yellowstone cutthroat
-- road removal – Grand Canyon
(D) Applications– Choice Experiments
-- Moose hunting / Alberta
-- Woodland caribou / Alberta
(E) Potential Methods for Sea Turtle
-- pelagic fishery in the West Pacific

Policy Issues and Examples in Wildlife Economic Applications

1) Project Evaluation
   a) Kootenai Falls
   b) Elwah dam removal
2) Habitat Acquisition
   a) Elk winter range
3) Land Management
   a) Bison & Brucellosis
   b) Wolf recovery
4) Pricing
   a) Montana State Lands Fee
   b) Nonresident elk permits
5) Litigation
   a) Exxon Valdez Oil Spill
   b) Clark Fork Superfund case
6) Resource Allocation
   a) Upper Missouri River Water Allocations

Accounting Framework

Framework	Method	Measure
Regional economics	Input/output model	Jobs, income
Benefit-cost analysis	Microeconomics (supply / demand)	Net benefits, B/C ratio

Categories
Economic Uses of Biological Resources

- Direct Use
  - Consumptive: fishing, hunting, gathering and genetic resources
  - Non-consumptive: wildlife viewing
- Indirect Use
  - Inputs to production: bees and pollination services
- Passive Use
  - Existence, bequest

Type of Use and Valuation Methods

Use	Method
Direct	Market Revealed preference (travel cost) Stated preference
Indirect	Hedonic property values Factor inputs
Passive	Stated Preference (Contingent valuation, conjoint analysis, contingent ranking, etc.)

Benefits of Bull Trout Critical Habitat Designation- Columbia R. and Klamath R. Basins

Benefit category	Population		
	Anglers	Tribes	Gen. Public
Direct use value – Sport fishing	X	X	
Existence value	X	X	X
Indirect use value (clean water, water temp., other species)		X	X

Stated preference methods

- Contingent valuation:
  - Describe scenario
  - Question format to elicit price: yes/no to given price (dichotomous choice); choose price (payment card); open ended (your maximum willingness-to-pay
- Choice experiments/conjoint analysis
  - Describe multi-attribute "products"
  - Price just one of many attributes
  - Question format to choose product: choose one (paired or multiple comparison), rating, ranking

Brief history of contingent valuation

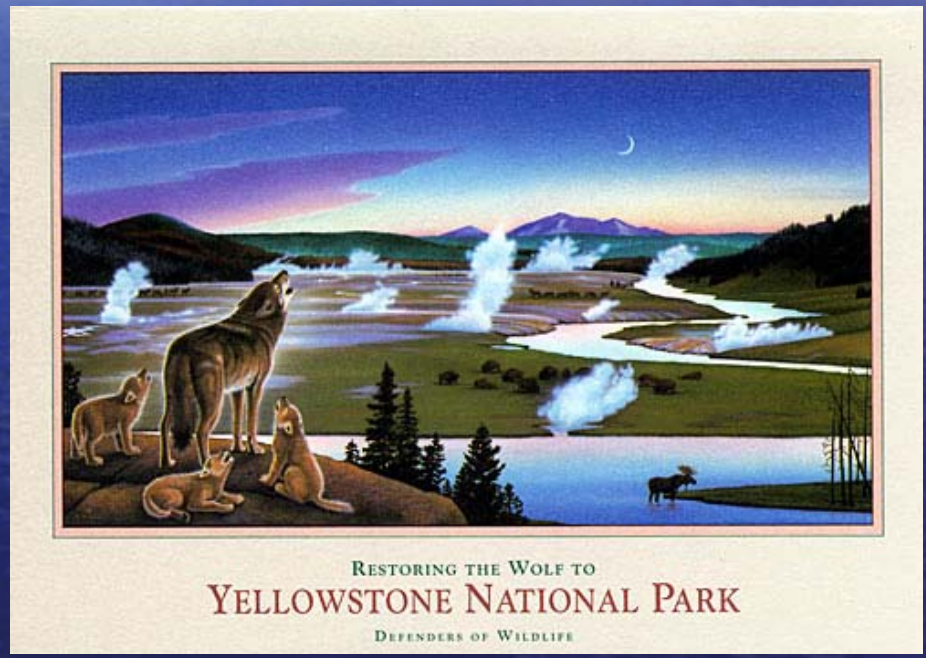
- 1947 – Hoteling letter to NPS
- 1950's – Davis application to Maine woods
- 1986 - "approved method" DOI NRDA reg
- 1989 – Mitchell and Carson text
- 1990 – Application to Exxon Valdez Spill
- 1993 – NOAA "blue ribbon" panel
- by mid-1990s in excess of 1000 studies

Contingent Valuation Study Design Issues

1) Human sample population
2) Definition of the good (attributes)
3) Payment vehicle
4) Question format
5) Supplemental data
6) Analysis methods

B. Contingent valuation applications

- Wolf recovery in Yellowstone NP
- Gray whales off West Coast US
- Sea turtles on SE coast US
- Summary of literature: meta-analysis



Wolf restoration policy issues

- Wolves exterminated in West by 1930
- USFWS proposals for wolf recovery in early 1980's
- Congress authorized Yellowstone/central Idaho wolf recovery EIS 1991
- Benefits: complete ecosystem, wildlife viewing
- Costs: predation on livestock, impacts on prey species (elk, deer, moose) and hunters, management costs
- Research question: is society better off with wolves?

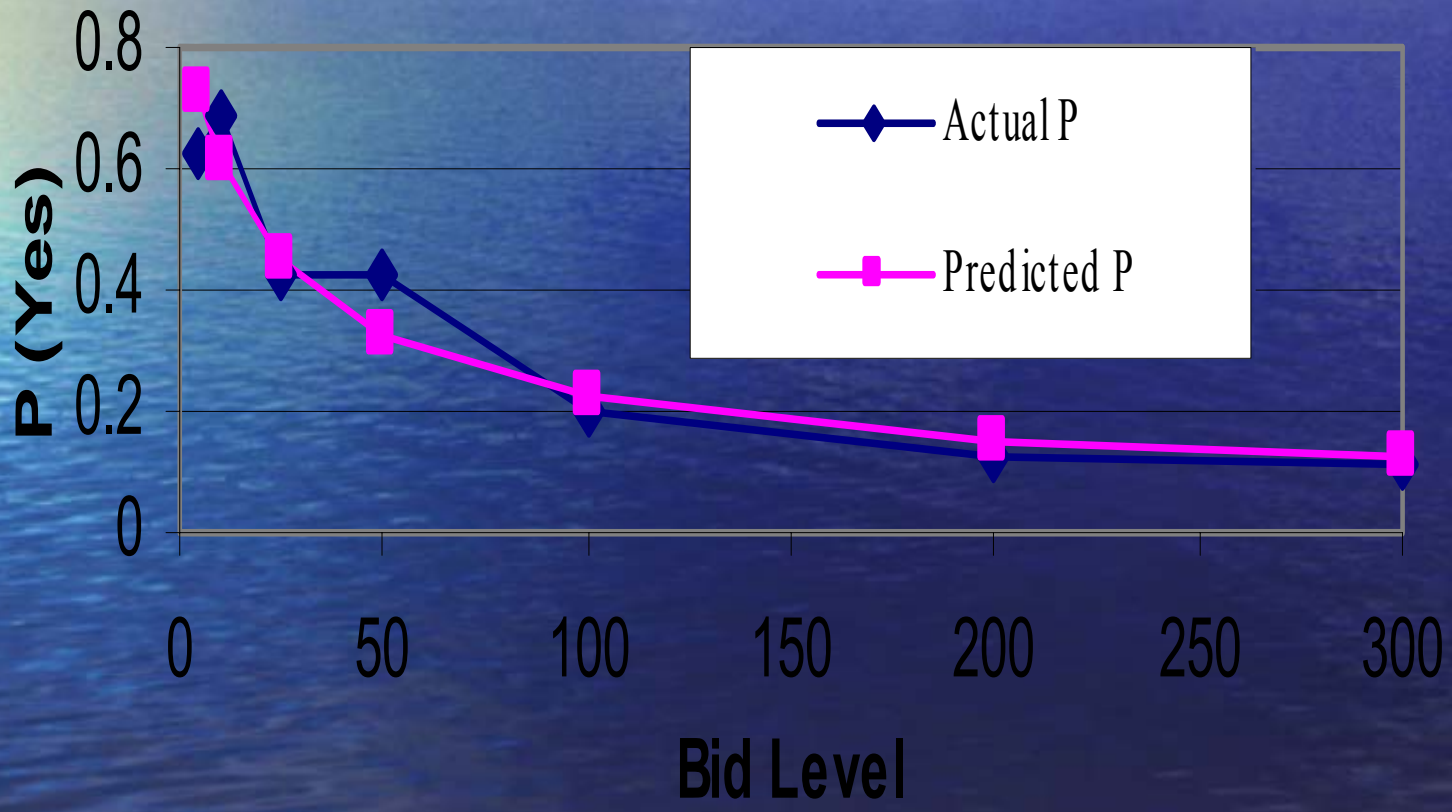
Question Sequence - wolves

- Respondents asked to assume:
- Trust fund essential for wolf recovery
- Respondent might see/hear wolves
- Donors have satisfaction of knowing wolves are present in Yellowstone NP
- Valuation question: "if you were contacted in the next month, would you purchase a lifetime membership in a trust fund for $ bid amount to support wolf recovery in Yellowstone Park?"
- Bid varied randomly $5 to $300 across surveys

Aggregate responses to Dichotomous Choice CV Question on Contribution to trust Fund to Support Wolf Recovery (Duffield 1992)

Bid level	N	"Yes" responses	Actual probability	Predicted probability
$5	54	34	.63	.72
$10	48	33	.69	.61
$25	81	35	.43	.45
$50	95	40	.42	.33
$100	133	27	.20	.23
$200	94	12	.13	.15
$300	81	9	.11	.12

Plot of Actual and Predicted Probabilities of a "yes" Response to Wolf Trust Fund CV Question (Duffield 1992)



Dichotomous Choice Contingent Valuation Methodology

(1) $$\Pi(t) = \Pr(WTP > t) = 1 - F(t)$$

(2) $$\Pi(t;\tilde{x}) = \left[1 + \exp(-\alpha t - \tilde{\gamma}\tilde{x})\right]^{-1}$$

(3) $$L = \ln(p/(1-p)) = \alpha t + \tilde{\gamma}\tilde{x}$$

(4) $$M_T = \int_0^T [1 - F(x)]dx$$

(5) $$\eta_p(\tilde{x}) = \exp(-\tilde{\gamma}\tilde{x}/\alpha)[p/(1-p)]^{-1/\alpha}$$

Estimated Net Economic Benefits Per Respondent for Bivariate Logistic Models for Wolf Recovery Trust Fund (1990$) (Duffield 1992)

Welfare measure	MT,ID, WY residents	Out-of-region residents	All
(A) Trust fund responses for wolf recovery total valuation			
Median	$15.38	$20.27	$18.68
Truncated mean	$59.04	$74.51	$69.97
75th Percentile	$62.27	$96.76	$84.97
(B) Trust fund responses for wolf existence value			
Median	$6.64	$14.20	$11.50
75th Percentile	$44.94	$88.73	$74.37

Multivariate Logistic Model of Wolf Recovery trust Fund Response (Total Valuation) (Duffield 1992)

Variable / Statistic	Entire Sample	Residents	Nonresident
Constant	-31.39	-34.56	-32.48
Log of bid amount	-0.984	-1.314	-0.918
Log of gross family income	0.4631	0.548	0.484
Log of 1-4 index of familiarity with trust funds	1.345	--	1.263
Log of composite variable related to desire to see wolves	3.589	7.594	2.764
Log of composite of environmental attitude variables	7.30	6.57	7.99
Dummy for high preference to see deer, elk or moose	-0.336	--	-0.336
Dummy for "hunts big game"	-0.522	-1.62	--
Sample size	524	158	366
Hosmer-Lemeshow P-value	0.86	0.896	0.133

Estimated Mean Values of Wolf Reintroduction in the Yellowstone Area

Welfare measure / statistic	3-state region (WY,MT,ID)	Out of region	All US residents
Mean value for supporters	$20.50	$8.92	
Mean value for opposed	$10.08	$1.52	
Population of supporters	391,202	50,152,416	
Population of opposed	340,522	25,774,280	
Aggregate NEV/year	$321,201	$28,572,785	
Scaler	0.286	0.286	
Estimated NEV per year (Standard Error)	$91,863 ($9,179)	$8,171,817 ($811,470)	8,263,680 ($811,522)

Annual Social Benefits and Costs of Yellowstone Wolf Recovery (Duffield and Neher 1996)

Benefit or cost category	Annual value in thousands of 1992 dollars	
	Low estimate	High estimate
(A) Benefits: Annual NEV of reintroduction	$6,673.1	$9,854.3
(B) Costs:		
Foregone value to hunters	187.3	464.9
Value of livestock losses	1.9	30.5
Annual wolf management cost	441.0	441.0
Total costs	630.2	936.4
net benefits of wolf recovery	6,042.9	8,917.9

Contingent Valuation Question Methods for Gray Whale Study (Loomis and Larson 1994)

1) Respondents were told the gray whale population was 20,000.
2) Respondents were told this population could be increased by reducing coastal pollution and restricting activities.
3) Payment vehicle was payment into the "Gray Whale Protection Fund."
4) Survey stated: "Legally the money could only be used to clean up coastal pollution and drift nets and purchase new calving waters."
5) Respondents were asked to state their WTP for a 50% and 100% increase in gray whale populations, and sightings.

Visitor and Household WTP for Increases in Whale Populations (Loomis and Larson 1994)

Scenario/Statistic	Visitor Sample		Household Sample	
	Mean	Std. Err.	Mean	Std. Err.
50% increase in population	$25.00	1.16	$16.18	1.07
100% increase in population	$29.73	1.39	$18.14	1.16
Sample size	672		519	

Contingent Market Design for Loggerhead Sea Turtle

(1) Respondents are informed about the current status of and threats to loggerhead sea turtle nesting habitat in North Carolina.

(2) Questions are asked concerning attitudes about extinction of the species, including risk.

(3) Respondents are introduced to a hypothetical preservation program designed to manage loggerhead sea turtle nesting habitat.

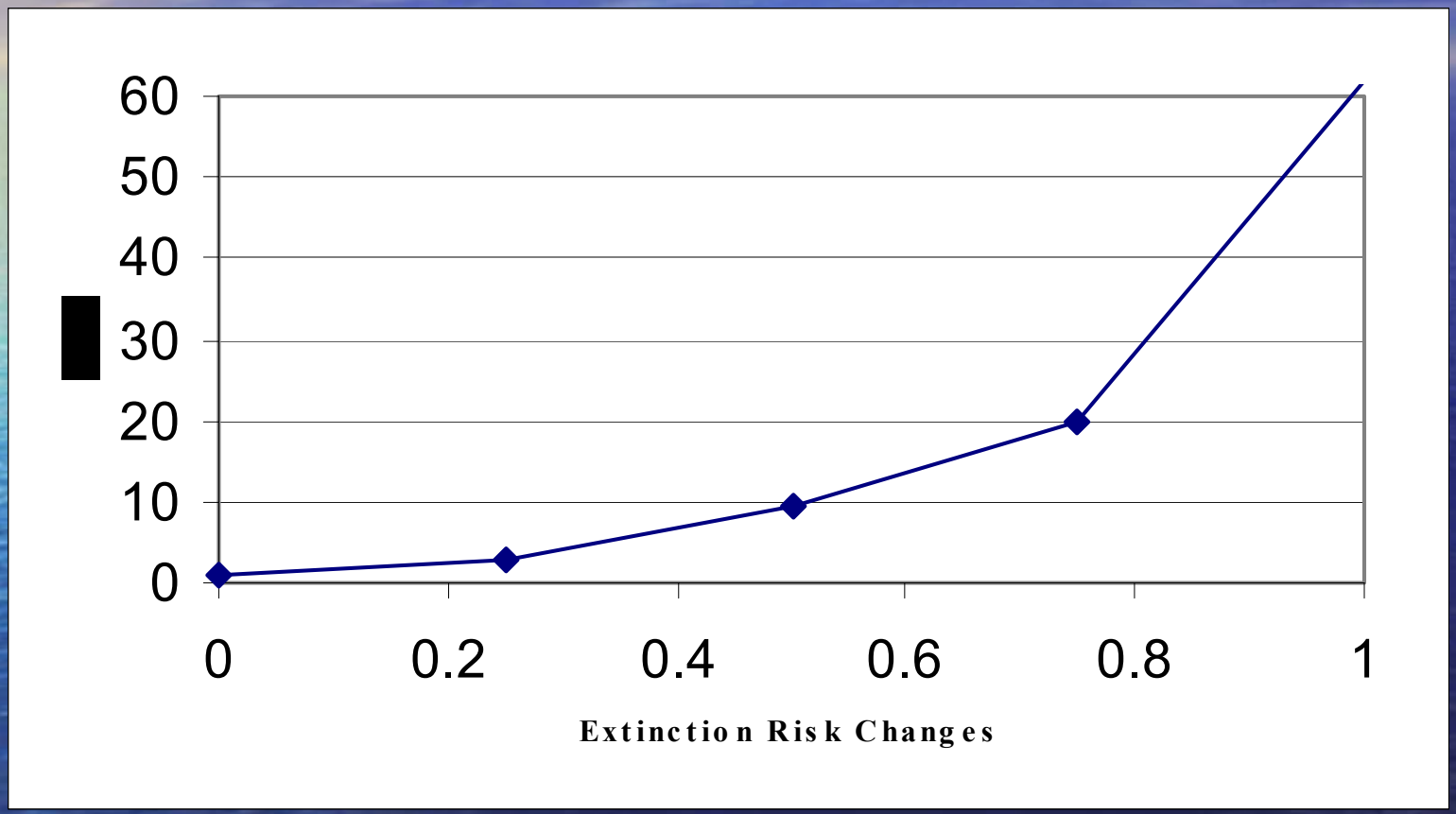
  (1) One-half are asked to assume that with the management program the turtle will definitely not become extinct within 25 years,

  (2) The other half are asked to assume that with the program the turtle will probably not become extinct within 25 years.

(4) Contingent Valuation Question: Suppose that a $A contribution from each North Carolina household each year would be needed to support and fund the loggerhead sea turtle program. Would you be willing to contribute $A each year to the 'Loggerhead Sea Turtle Preservation Trust Fund' in order to support the loggerhead sea turtle program?"

(5) Each respondent is randomly assigned on of the following dollar values $A= 1, 5, 10, 25, 50, 100. Respondents answer "yes" or "no".

The Effect of Perceived Program Effectiveness on Total WTP for Wildlife Preservation: Loggerhead Sea Turtle Study



Literature summary: endangered species meta-analysis

- List of studies, species, value estimates, payment vehicle, question format
- Summary list of values
- Meta-analysis equation: do studies as a whole show statistically significant effect to size of the change, payment frequency, question format, visitor vs household sample, species group (e.g. marine)

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Reference	Date	Gain or Loss	Size of Change
Whooping crane	Bowker & Stoll (1988)	1983	Avoid loss	100%
Whooping crane	Bowker & Stoll (1988)	1983	Avoid loss	100%
Bald Eagle	Boyle & Bishop (1987)	1984	Avoid loss	100%
Striped shiner	Boyle & Bishop (1987)	1984	Avoid loss	100%
Grizzly Bear	Brookshire et al. (1983)	1983	Gain for hunting permits	--
Bighorn sheep	Brookshire et al. (1983)	1983	--	--
Bald eagle, Peregrine, Kelp bass, White croaker	Carson et al. (1994)	1994	Speed recovery from a natural 50 year period to 5 years	--

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	WTP – Lump sum	WTP – Annual	CVM method	Survey Region
Whooping crane	--	$31.81	DC	TX and US
Whooping crane	--	$49.92	DC	Visitors
Bald eagle	--	$15.40	DC	WA households
Striped shiner	--	$6.04	DC	
Grizzly bear	--	$36.58	OE	WY hunters
Bighorn sheep	--	$29.86	OE	
Bald eagle, peregrine. Kelp bass, White croaker	$63.24	--	DC	CA households

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Sample Size	Response Rate	Payment Vehicle
Whooping crane	316	36%	Foundation
Whooping crane	254	67%	Foundation
Bald eagle	365	73%	Foundation
Striped shiner			
Grizzly bear	810	27%	Wildlife stamp
Bighorn sheep			
Bald eagle, peregrine. Kelp bass, White croaker	2810	73%	One-time tax

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Reference	Date	Gain or Loss	Size of Change
Squawfish	Cummings et al. (1994)	1994	Avoid loss	100%
Gray wolf	Duffield (1992)	1992	Reintroduction	
Gray wolf	USDOI (1994)	1993	Reintroduction	
Arctic grayling	Duffield & Patterson (1992)	1992	Improve 1 of 3 rivers	
Cutthroat trout	Duffield & Patterson (1992)	1992	Improve 1 of 3 rivers	
Gray-blue whale	Hageman (1985)	1984	Avoid loss	100%
Sea Otter	Hageman (1985)	1984	Avoid loss	100%

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	WTP –Lump sum	WTP – Annual	CVM method	Survey Region
Squawfish	--	$8.42	OE	NM
Gray wolf	$69.67	--	DC	US visitors
Gray wolf	$20.50	--	DC	Region Household
Arctic grayling	$17.36	--	DC	US visitors
Cutthroat trout	$13.02	--	DC	US visitors
Gray-blue whale	--	$33.33	PC	CA households
Sea Otter	--	$28.88	PC	CA houseolds

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Sample Size	Response Rate	Payment Vehicle
Squawfish	921	42%	Increase state taxes
Gray wolf	389	86%	Lifetime membership
Gray wolf	335	70%	Lifetime membership
Arctic grayling	157	27%	Trust fund
Cutthroat trout	170	77%	Trust fund
Gray-blue whale	180	21%	Increase Federal tax
Sea Otter	174	--	Increase Federal tax

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Reference	Date	Gain or Loss	Size of Change
N. Spotted owl	Hagen et al. (1992)	1990	Avoid loss	100%
Bighorn sheep	King et al. (1988)	1988	Avoid loss	100%
Gray whale	Loomis & Larson (1994)	1991	Gain	50%
Gray whale	Loomis & Larson (1994)	1991	Gain	100%
Salmon & Steelhead	Olsen et al. (1991)	1989	Gain	100%
Salmon & Steelhead	Olsen et al. (1991)	1989	Gain	100%
Red cockaded woodpecker	Reaves et al. (1994)	1992	% chance of survival	99%

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	WTP –Lump sum	WTP – Annual	CVM method	Survey Region
N. Spotted owl	--	$95.42	DC	US households
Bighorn sheep	--	$12.36	OE	AZ households
Gray whale	--	$17.15	OE	CA households
Gray whale	--	$19.23	OE	CA households
Salmon & Steelhead	--	$31.29	OE	PNW Households
Salmon & Steelhead	--	$88.40	OE	PNW anglers
Red cockaded woodpecker	--	$10.64, $14.82, $9.52	OE, DC, PC, respectively	SC&US households

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Sample Size	Response Rate	Payment Vehicle
N. Spotted owl	409	46%	Taxes & wood prices
Bighorn sheep	550	59%	Foundation
Gray whale	890	54%	Protection fund
Gray whale	890	54%	Protection fund
Salmon & Steelhead	695	72%	Electric bill
Salmon & Steelhead	482	72%	Electric bill
Red cockaded woodpecker	225, 223, 234	53%, 52% 53%	Recovery fund

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Reference	Date	Gain or Loss	Size of Change
Spotted owl	Rubin et al. (1991)	1987	% change survival	75%
Monk seal	Samples & Roityer (1989)	1988	Avoid loss	100%
Humpback Whale	Samples & Roityer (1989)	1988	Avoid loss	100%
Atlantic Salmon	Stevens et al. (1991)	1989	Avoid loss	100%
Bald eagle	Stevens et al. (1991)	1989	Avoid loss	100%
Bald eagle	Swanson (1993)	1993	Inc. in pop.	300%
26 species in CO	Walsh et al. (1985)	1985	Avoid loss	100%
Sea turtle	Whitehead(1992,1992)	1991	Avoid loss	100%

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	WTP –Lump sum	WTP – Annual	CVM method	Survey Region
Spotted owl	--	$28.09	OE	WA households
Monk seal	$119.70	--	DC	HI households
Humpback Whale	$172.92	--	DC	HI households
Atlantic Salmon	--	$7.29	DC	WA visitors
Bald eagle	--	$32.94	DC	N.E. households
Bald eagle	$254.63	--	DC	WA visitors
26 species in CO	--	$58.00	OE	CO households
Sea turtle	$12.99	--	DC	NC households

Willingness to Pay Per Household (1993$) for Rare and Threatened/Endangered Species

Species	Sample Size	Response Rate	Payment Vehicle
Spotted owl	249	23%	Unspecified
Monk seal	165	40%	Preservation fund, money and time
Humpback Whale	165	40%	Preservation fund, money and time
Atlantic Salmon	169	30%	Trust fund
Bald eagle	339	37%	Trust fund
Bald eagle	747	57%	Membership fund
26 species in CO	198	99%	Taxes
Sea turtle	207	35%	Preservation fund

Summary of Economic Values of Rare and Threatened and Endangered Species (1993$) Annual WTP studies

Species	Low value	High value	Average
N. Spotted owl	$44	$95	$70
Pac. Salmon/Steelhead	$31	$88	$63
Grizzly bears			$46
Whooping cranes			$35
Red-cockaded Woodpecker	$10	$15	$13
Sea otter			$29
Gray whales	$17	$33	$26
Bald eagles	$15	$33	$24
Bighorn sheep	$12	$30	$21
Sea turtle			$13
Atlantic salmon	$7	$8	$8
Squawfish			$8
Striped shiner			$6

Summary of Economic Values of Rare and Threatened and Endangered Species (1993$) Studies Reporting Lump-sum WTP

Species	Low value	High value	Average
Bald eagles	$178	$254	$216
Humpback whales			$173
Monk seal			$120
Gray wolf	$16	$118	$67
Arctic grayling/Cutthroat Trout	$13	$17	$15

Meta-analysis Results: Regression for WTP of ESA Species (sample-38, Adj R sq. 0.682)

Variable (t-statistic)	**Linear model**
Changesize	0.59 (5.06)
Payfrequency	45.51 (2.89)
CVform	14.33 (1.12)
Visitor	24.03 (1.71)
Fish	24.26 (1.31)
Marine	49.87 (2.58)
Bird	33.41 (1.85)

C. Examples of validation studies

- Cash transactions experiment: comparison of hypothetical and cash donation request (through a Nature Conservancy trust fund payment vehicle) to augment instream flows for two Montana threatened fish.
- Cash transaction experiment: actual and hypothetical donation for removing roads from N. Rim Grand Canyon

MONTANA-GRAYLING

ARCTIC GRAYLING RECOVERY PROGRAM

Arctic Grayling / Yellowstone Cutthroat Sample Size and Response Rate

Subsample	Delivered	Returned	
		N	Percent
A) Residents			
Cash –TNC	2,278	205	9.0
Hypo – TNC	1,013	193	19.1
B) Non-residents			
Cash –TNC	2,372	306	12.9
Hypo – TNC	1,054	288	27.3

Arctic Grayling / Yellowstone Cutthroat Frequency Distribution of Contributions

Subsample	N	Percent by dollar amount				
		10	25	50	100	250
A) Residents						
Cash –TNC	26	54	42	4	0	0
Hypo – TNC	60	75	18	7	0	0
B) Non-residents						
Cash –TNC	136	41	35	17	6	1
Hypo – TNC	157	39	36	17	8	1

Arctic Grayling / Yellowstone Cutthroat

Sample	Average WTP per contributor	Average WTP per respondent
A) Residents		
Cash –TNC	17.69	2.24
Hypo – TNC	14.92	4.64
B) Non-residents		
Cash –TNC	28.43	12.60
Hypo – TNC	31.85	17.36

Percentage Yes Responses to Willingness to Donate Question by Treatment and Offer Amount

Bid/statistic	AD (1993)	DC CD (1993)	CDWC (1994)	CDWC (1994)
$1	.24	.53	*	*
$5	.15	.51	*	*
$8	.25	.39	*	*
$12	.17	.48	*	*
$15	.13	.39	.60	.23
$50	.04	.34	.36	.12
$75	*	*	.34	.03
$100	*	*	*	*
$150	*	*	*	*
$200	*	*	*	*
Est. WTP	$9	$46	$52	$12
Source: Champ et al. (1997).				

D. Choice Experiments

- Direct use application: moose hunting
- Passive use application: woodland caribou protection

Attributes Used in Stated Preference Experiment (Adamowicz et al. 1997)

Attribute	Level
Moose population	Evidence of <1 moose per day; Evidence of 1-2 moose per day; Evidence of 3 or 4 moose per day
Hunter congestion	Encounter no other hunters; Encounter other hunters on foot; Encounter other hunters on ATV's; Encounter other hunters in trucks
Hunter Access	No trails, cutlines or seismic lines; Old trails passable with ATV's; Newer trails passable with 4WD; Newer trails passable with 2WD.
Forestry activity	Evidence of recent forestry activity; No evidence of recent forestry activity
Road quality	Mostly paved, some gravel and dirt; Mostly gravel and dirt, some paved
Distance to site	50 km; 150 km; 250 km; 350 km

Example of Survey Instrument Used to Gather Stated Preference Data (Adamowicz et al. 1997)

Features of Hunting Area	Site A	Site B	
Distance from home to hunting area	50 km	50 km	Neither Site A nor Site B I will NOT go moose hunting
Quality of road from home to area	Mostly gravel or dirt, some paved	Mostly paved, some gravel/dirt	
Access within hunting area	Newer trails passable with 2WD	Newer trails passable with 4WD	
Encounters with other hunters	No hunters are encountered	Other hunters on ATV's are seen	
Forestry activity	Some evidence of recent logging	No evidence of logging	
Moose population	Evidence of < 1 moose per day	Evidence of < 1 moose per day	

Attributes and Levels Used in Choice Experiments (Adamowicz et al. 1998)

Attribute	Levels
Maintain caribou population (caribou numbers)	50, 400, 600, 1,600
Wilderness area (hectares)	100,000, 150,000, 220,000, 300,000
Recreational restrictions (categories)	Level 1-no restrictions Level 2-Activities in designated areas Level 3-no hunting, fishing, ORV, helicopters: horses and camp in designated areas Level 4-3-no hunting, fishing, ORV, helicopters, horses; hiking on designated trails, limited overnight camping
Forest industry employment	450, 900, 1200, 1250
Change in prov. Income tax	-$50, no change, +$50, +$150

Welfare Measures for Caribou Management Program (Adamowicz et al. 1998)

Model	Linear	Quadratic
Contingent Valuation (std. dev.)	142.82 (66.09)	140.86 (1,504.85)
Intercept excluded		
Choice experiment	91.84 (35.35)	217.83 (42.44)
Joint model	92.02 (35.94)	209.35 (46.66)
Intercept included		
Choice experiment	-116.29 (35.13)	76.70 (29.02)
Joint model	-105.18 (33.88)	75.42 (27.92)

E. Potential methods for sea turtle valuation

- human population to sample
- definition of the "product to be valued"
  - Key attributes of the product or policy
- payment vehicle
- general method
- question format

Preliminary Concepts for a Sea Turtle Valuation Study in the Western Pacific

1) Nested population sample
   - Hawaii fishing community
   - State of Hawaii
   - Entire US
2) The good
   - Increased populations / decreased risk of extinction
   - Reduced by catch
3) Payment vehicle
   - Taxes / retail fish prices
4) General methods/question format
   - Both choice experiment and contingent valuation
   - referendum format: increased taxes
   - referendum format: increased retail fish prices

Final EIS: Pelagic Fisheries, Selected Alternatives

- Alternative 1. Pelagic FMP (no action – pre-injunction baseline)
- Alternative 3. Pelagic FMP as modified by court
- Alternative 6. Closure of area north of 29 N latitude by Hawaii-based vessels at all times, Closure of all to longline April-July
- Alternative 10. (Preferred Alt.) Prohibition of swordfish-style sets N. of equator, April-May closure equator to 15 degrees north.

Final EIS: Pelagic Fisheries of Western Pacific (2001) Effectiveness of Alternatives as Mitigation

Indicator	Alt 1	Alt 3	Alt 6	Alt 10
No. of vessels	119	77	86	92
No. of crew	610	417	445	504
Total fishery gross revenue ($M)	40.7	24.1	29.1	29.6
Loggerhead mortality	87	19	32	0
Leatherback mortality	9	3	2	2
Olive Ridley mortality	49	40	39	19
Black-footed albatross	1283	250	128	15